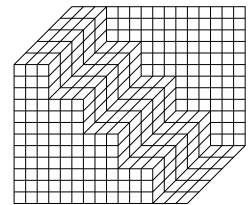


Hayle Harbour

Maintenance Dredging Protocol Document

Job no 022961 May 2010

Revision 03 Final



Buro Happold

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author **Wayne Adams**

signature



date **April 2010**

The following signatures are to confirm that this Protocol has met the conditions of the Penwith CPA Dredge Licence. It does not indicate agreement to all of the content or acceptance to future maintenance or capital dredging works, all of which will be subject to new licence information and supporting documentation.

Name	Organisation	Signature
Simon Mansell	Cornwall Council (Legal)	
Jennie Christie	Cornwall Council (Environmental)	
Andrew McDouall	Natural England	
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1 Executive Summary

This Dredging Protocol Document has been prepared by Buro Happold on behalf of Hayle Harbour Authority Limited (HHA) to record the historical activity of maintenance dredging within Hayle Harbour.

This Document has been provided in accordance with the requirements of clause 4.4 of the Licence to Dredge granted to Hayle Harbour Management Limited issued by Penwith District Council dated 7th May 2008 which has now expired. It therefore relates only to that licence and not to any future application to dredge that may be made by Hayle Harbour Authority Limited. It is recognised that all dredging has been suspended in Hayle Harbour until such time that a review into the methods available to keep the entrance channel open and for any future dredging requirements has been completed.

This Document has been prepared in accordance with the guidance given in Maintenance Dredging and The Habitats Regulations 1994, Conservation Assessment Protocol. It should be recognised that this has been requested to meet good practice and not as part of the Habitats Regulations through which Natural England would have a specific role in the establishment of this protocol. All environmental consultees are therefore expected to support and enhance this document with appropriate historical information and data.

This Document includes consideration of dredging methods, volumes and frequencies of dredging, transport and disposal of dredged material, restrictions imposed on dredging, mitigation methods put in place, and the history of dredging in the given area.

The maintenance dredging in Hayle Harbour doesn't include the removal of the Cockle Bank or support any other harbour development or capital dredging need. It is required solely to ensure the safety of harbour users when navigating to and from the quays and out into St Ives Bay.

2 Need for Maintenance Dredging at Hayle Harbour

2.1 Maintenance Dredging Demand

The harbour has historically been used by coasters supplying coal to the power station and oil to the fuel terminal. Prior to that, other cargoes, ship-building and significant industries required large vessels to access the port. Access was facilitated through the provision of a defined channel to the quays that now provide berths for commercial fishing and leisure users. Details of the historical channel are provided in the original navigation charts and in the aerial photography provided in Section 10 of this Protocol.

In the past the harbour channels were routinely cleared through a combination of sluicing techniques and traditional dredging practices. This prevented excessive build up of sand within the navigable areas although there is no definitive conclusion as to the effectiveness of the sluicing and the need for additional dredging to be maintained. Historically, it is understood that sand was used on agricultural land but the volumes are not recorded. More recently in 2004, the practice of dredging with mechanical plant on the beach was stopped due to public concern that the sand wasn't being dredged for the purposes of user safety.

The importance of Hayle as a port facility remains to the extent that Trinity House (the body responsible for the management of ports and lighthouses in the UK) has also called upon the port authority to dredge the estuary or face potential legal action. The demand for dredging was highlighted by harbour users and contained within press publications in 2007 and 2008, "The Cornishman", as reproduced below.

FEARS THAT SHIFTING SANDS ARE MAKING CHANNEL DANGEROUS
Date : 27.12.07

Fishermen and boat users in Hayle fear that shifting sands are making the harbour channel dangerous and almost impossible to navigate. They are concerned that unless harbour owners ING Real Estate invest seriously in a sluicing and dredging regime, yachts and smaller fishing boats could be sunk as they dog-leg their way in and out of the port.

The Harbour Users Association (HUA) has commissioned an aerial photograph which reveals how far the channel has deviated from its previous path.

The view clearly shows a shallow and meandering river which has moved some way to the east of a line of poles marking out its usual route.



BOAT USERS' SAFETY FEARS OVER ESTUARY**Date : 04.01.08**

Shifting sands in Hayle estuary have moved so far from the original channel that boat owners and fishermen are campaigning for the area to be dredged. The riverbed has changed so much that vessels are regularly stranded on the sand and many people fear it is only a matter of time before the shallows cause a serious incident.



Although many residents fought hard to save Hayle's sand from being dredged and sold, which was the practice for 17 years, the town is now confronted with the issue of safety.

2.2 Current Maintenance Dredging Need

The harbour currently provides access to the sea for small commercial fishing craft and a variety of leisure craft. In 2010 there were approximately 25 commercial berths and 127 leisure berths occupied within the harbour. In addition to this, there is use by a commercial operator (Mojo) and the cutter suction dredger (Tay Sand). The photograph below shows one of the vessels operated by Mojo, at another harbour.



Harbour users recognise the depth limitations provided within the harbour and use the large tide range to ensure access to their berths. However, the harbour channel which previously existed during more significant shipping activity no longer exists. This makes access into the harbour from St Ives Bay difficult and hence the current maintenance dredging has focussed on providing a safer access channel.

The aim of the current maintenance dredging is to maximise flow in/out of the harbour to generate natural flushing of the channel and bar in order to maintain the depths and improve navigation along the channel and across Hayle bar. This is being achieved by targeted dredging of the harbour and the channel. During good weather conditions the Hayle bar is dredged but this can only be done when access is possible during periods of high spring tides and when wave conditions allow.

The dredged volumes estimated for the initial licence in 2008 was based upon the operational capacity of the dredger. This was essentially the number of suitably high tides that the dredger could safely operate and the breakdown is shown below.

Hayle High Tides (6.5+m) for 2008 - Month	No of high tides 6.5+ m during the AM Period	No of high tides 6.5+ m during the PM Period	Total in Month
January	14	10	24
February	12	11	23
March	13	13	26
April	10	10	20
May	6	6	12
June	6	6	12
July	9	15	24
August	12	15	27
September	13	15	28
October	16	16	32
November	12	7	19
December	12	6	18
2008 TOTAL	135	130	265

This assumed tides worked are any of the 130 over the level of 6.5m either am / pm. For the Tay Sand cutter suction dredger, the daily output is likely to be restricted to only 200t, hence a total dredge = 26000t. If all tides over +6.5m are achieved then the total dredge would be 53000t – this was the consented value for 2008 - 2010.

Shown in Figure 1 below is the area of maintenance dredging, as referred to in the Penwith District Council CPA Licence, which is due to be replaced by a Cornwall Council licence as the current licence has now expired.

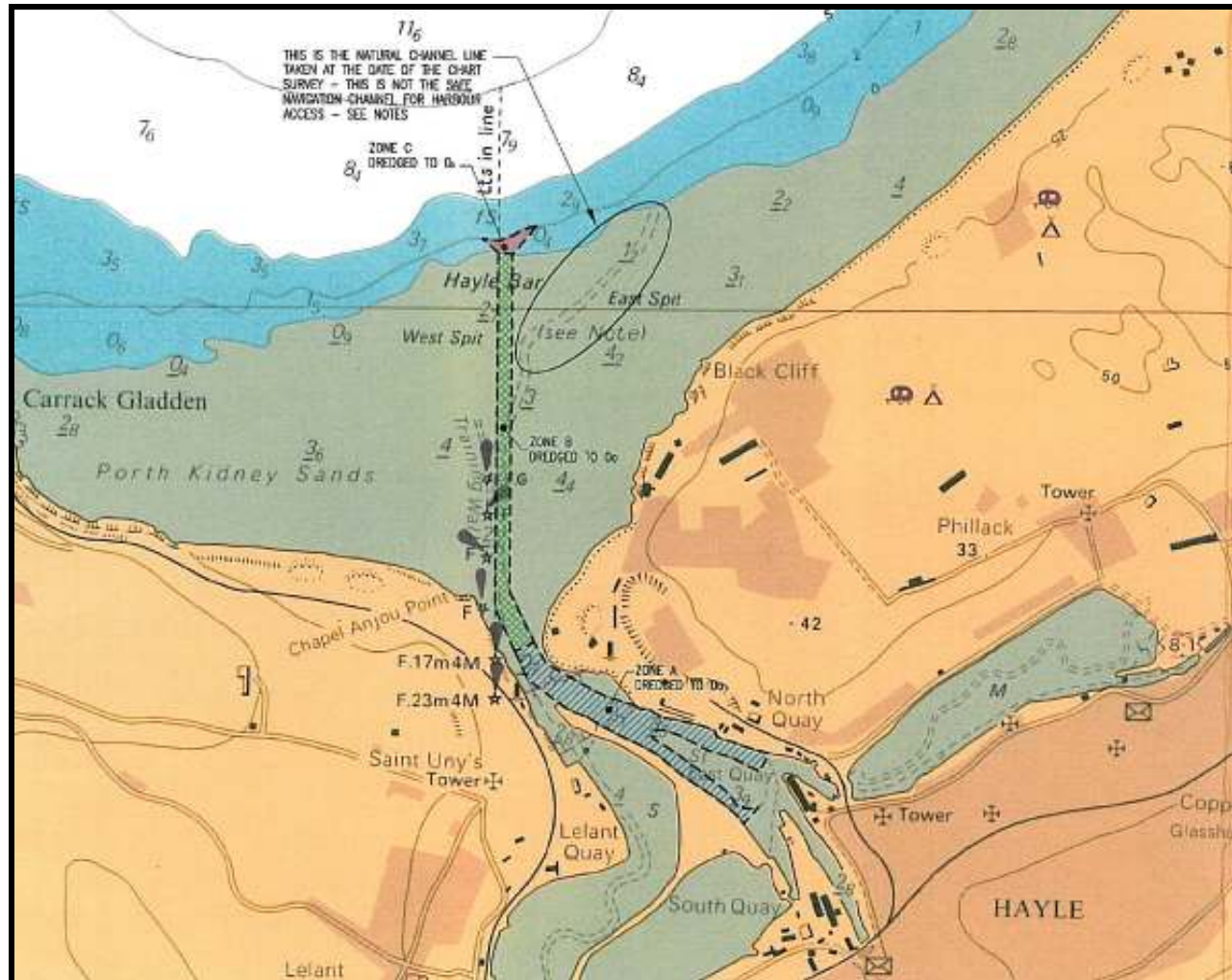


Figure 1: Locations of Maintenance Dredging

2.3 Dredging Locations

The dredging area shown in Figure 1 is split into zones in order to assist instructions to the dredging contractors, the recording of dredging operations and the identification of better practices within the areas specified. The current proposed zones are:

Zone A – Inner Harbour – target to be dredged to 0.0m CD

Zone B – Approach Channel – target to be dredged to 0.0m CD

Zone C – Hayle Bar – target to be dredged to 0.5m CD

The target dredge depths and channel widths provided are for safe leisure and small commercial use. Although unlikely, any large commercial craft may need bespoke dredging for which a capital dredge licence would be necessary.

2.4 Dredging Volumes

Following the completion of the initial dredging in 2009/10 it is currently anticipated that the weight of sand requiring dredging to achieve the target depths and channel widths indicated in Figure 1 will be approximately 400,000 tonnes and this can be broken down as indicated in Table 1 below:

Location	Dredge Depth (m CD)	Dredge Width (m)	Volume (m ³) using 1.8 t/m ³	Weight (Tonnes)
Zone A – Inner Harbour	+0.0	To match existing channel width	0	0
Zone B – Approach Channel	+0.0	40m maximum width (including the side slopes)	73,500	132,300
Zone C – Hayle Bar	+0.5	40m – 60m as indicated Fig.1	120,6000	217,0800
		TOTAL	193,900 m³	349,380 t

Table 1 – Anticipated Dredge Requirements

The total figures provided in Table 1 do not include the amount of material that is returned yearly into the harbour by the predominant waves in St Ives Bay, as discussed further in 2.5 below.

2.5 Future Dredging Requirements

It is considered necessary to continue maintenance dredging or harbour clearance to maintain the zones identified above. Surveys of sand ingress indicate that to maintain the harbour will need an ongoing removal of sand. The volumes have been predicted but regular bathymetric surveys provided during the maintenance dredging operations will assist in the measurement of the likely ingress.

The hydrodynamic modelling (Hydraulic Studies Phase 2 – August 2007) for the Outline Planning Application shows a net influx of sand of between 10,000 and 20,000m³ per year, equivalent to 18,000 to 36,000t per year and that this will vary depending on the effectiveness of sluicing systems used.

There may be capital dredging requirements as part of the Hayle Harbour redevelopment. However, these do not form part of this protocol and would require separate approvals and consents. The protocol will continue to inform the future capital dredging processes as well as any ongoing maintenance dredging requirements.

3 Statutory and Policy Context

3.1 General

There are numerous policies surrounding the requirements for maintenance dredging, none of which are exactly the same for every UK harbour. The **Marine and Coastal Access Act 2009** provides for changes to marine licensing and its aim is to encompass other consents and licence requirements for the marine environment. It is anticipated that all dredging licences will be issued by the Marine Management Organisation (MMO) and that Cornwall Council will in the future become a consultee rather than a decision maker. Other policies that have a relevance to the maintenance dredging include the following:

- **Coast Protection Act 1949**

Certain marine works within Hayle Harbour fall within the scope of the Coast Protection Act 1949. The Act sets out to control activities in, and to protect, the coastal zone. Under the Hayle Harbour Act 1989, the Harbour Authority (Hayle Harbour Company Ltd) has powers to undertake certain works within the harbour. These powers include the ability to carry out dredging within the harbour, and to dispose of the material arising in a prescribed way.

- **St Ives Bay Coast Protection Order 2003**

Under the Coast Protection Act 1949, Penwith District Council has powers to control certain activities within the coastal zone. Under Section 18 of that Act, in 2003, PDC put in place an Order, prohibiting the excavation or removal of materials from the sea shore, except under licence from PDC. The aerial extent of the order, known as the Penwith District Council, St Ives Bay Coast Protection Order 2003, includes Hayle Harbour. Notwithstanding the provisions of the Hayle Harbour Act 1989, the Harbour Authority has entered into a licence, under the provisions of the St Ives Bay Coast Protection Order, in relation to the carrying out of dredging within the harbour.

- **European Commission Dangerous Substances Directive (76/464/EEC)**

This directive controls the release of dangerous substances to water. Various substances are listed in the Annex to the Directive as either List I or List II substances, with List I substances considered the most harmful to human health and the aquatic environment. The purpose of the directive is to eliminate pollution from List I substances and reduce pollution from List II substances. The directive will be integrated into the EC Water Framework Directive with List I substances replaced by a 'List of Priority Substances' included in the WFD. The rest of the Dangerous Substances Directive will remain in place until 2013 (transition period).

- **Pollution Prevention Guidelines (PPGs)**

Pollution Prevention Guidelines (PPGs) have been issued by the EA and a number of these guidelines are relevant. In particular, PPG 6 provides guidance on control of water pollution during construction and demolition stages of works. Compliance with these PPGs will need to be considered as part of the environmental management documentation developed for demolition, construction and operational phases of the development.

- **Local policy framework - Penwith Local Plan 2004**

The Local Plan provides the strategic base for all land use planning in the Penwith area for the period up to 2007

Policy CC-7 states that proposals for development which would significantly harm the nature conservation value or geological interest of a Site of Special Scientific Interest will not be permitted.

Policy CC-8 states that development will not be permitted where it would significantly harm the nature conservation or geological interest of areas of great scientific value, county wildlife site, county geological sites, ancient woodland sites and local nature reserves. Where development is permitted any impact on such values must be minimised and conditions will be imposed, or a planning obligation sought, to ensure that mitigating measures are undertaken.

Policy CC-14 states that proposals for development which would have a significant adverse effect on the shoreline or adjacent coastal waters in terms of its landscape character, amenity, nature conservation, archaeological, historic and geological values will not be permitted.

- **Food and Environment Protection Act (FEPA) licence**

A Food and Environment Protection Act (FEPA) licence is required from the Department of Food and Rural Affairs if any material is disposed of below mean high water springs levels. In addition the Hayle Harbour Act may impose or relinquish some additional requirements.

- **Shoreline Management Plan**

SMP 2 which local authorities must consider in making development management decisions relating to the coast (as set out in Planning Policy Statement 25 development and coastal change).

- **Natural Environment and Rural Communities Act**

Biodiversity Duties of Public Bodies (which includes Local Authorities and Harbour Authorities) under the Natural Environment and Rural Communities Act who must 'have regard for biodiversity' in decision making.

3.2 The Environmental Permitting (England & Wales) Regulations 2010

As agreed with the Environment Agency in 2008 under the Waste Management Licensing Regulations (1994), because the sand is defined as a “Controlled Waste” it is a legal requirement to comply with the waste regulations and for any transportation of the material to be undertaken by a registered waste carrier who must also produce a waste transfer note. To become a registered waste carrier EA Form WMC1 is to be completed and submitted with an application fee of £154 (2010 – 2011 Charges). The registration certificate issued is then valid for a period of three years before renewal is required.

The Environmental Permitting (England & Wales) Regulations 2010 came into effect on 6 April making significant changes to the exemption and permitting regimes. Under transitional arrangements any farm with a paragraph 15 exemption in place may continue to benefit from this until 1- October 2010 at which time the activity should either cease, be registered exempt under one of the new exemptions where applicable or the operator should obtain an environmental permit. There is no new exemption to cover the use of dredged sand as cattle bedding. Landspreading dredged sand (controlled waste) on agricultural land may taken place under a standard permit “Mobile plant for landspreading” with a suitable deployment registration for each proposed site of spreading. This regime is significantly more onerous than the paragraph 7 exemption it replaces.

The Environment Agency will be looking into the particular circumstances as relates to the classification of the dredged sand at Hayle as controlled waste to consider if there is any means under which the sand may be considered as non-controlled waste. It is hoped this will be carried out at the end of 2010.

The process for the waste management of the sand under the recently expire Penwith licence is as indicated in Figure 2 below.

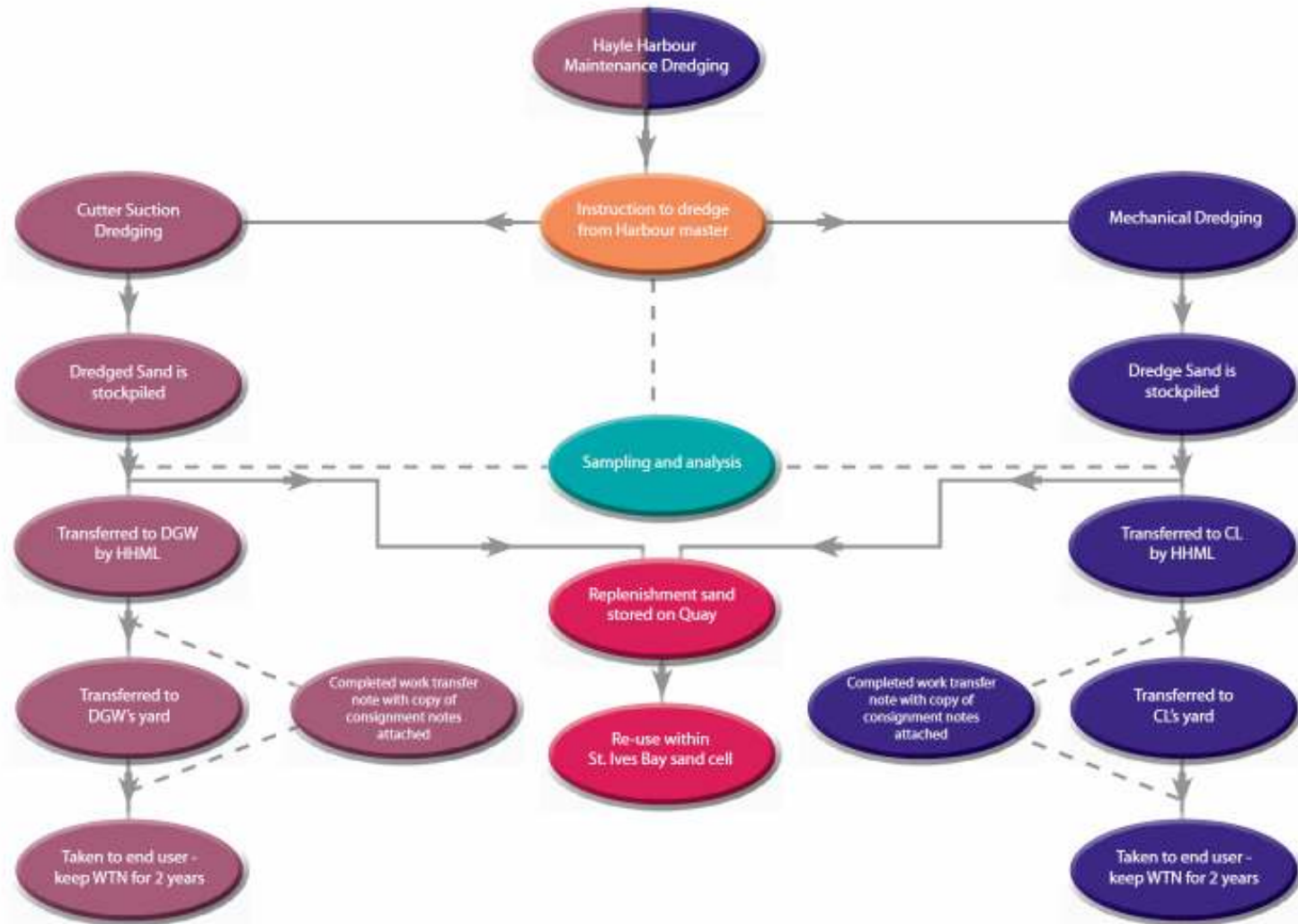


Figure 2 – Waste Management Process

4 Methods of Dredging and Transporting Sand

4.1 Dredging Methods

Numerous dredging methods exist and have been investigated during the development of the maintenance dredging activities.

4.1.1 Sluicing

Historically, the channels were kept clear using the water from Copperhouse and Carnsew Pools for sluicing. The infrastructure at Copperhouse has long since been replaced by a Swimming Pool and the Environment Agency's Flood Gate. Whilst, the flood gate has been used in part as a sluice, it has not been used on a regular basis and is not designed to do so. Carnsew Pool's sluicing infrastructure has also long been removed and significant investment would be needed in both areas if this was to be re-employed. However, initial investment in clearing the harbour channels would be needed as sluicing would only maintain the channel depths rather than deepen them directly. The ability to sluice is also severely restricted by environmental concerns, limiting it to summer operation on spring tides. Initial modelling indicates a minimum of 20,000m³ (40,000 tonnes) needing annual removal from the harbour by other dredging or clearing techniques. This is the same volume as dredged in 2008 to 2010 without any sluicing being used.

4.1.2 Mechanical Dredging

Removal of sand using an excavator and dump trucks was used historically but the works are difficult to undertake within the main channel areas. The ability to monitor the benefit of this type of dredging is difficult and requires significant investment in supervision. This method should therefore only be applied in areas where it is absolutely necessary.

4.1.3 Cutter Suction Dredging

This method has become the method of choice despite the process being slow because of the vessel size restrictions. The current vessel, Tay Sand, is able to remove sand from specific areas and off load using an excavator to the quay-side for re-use. This vessel is not currently suitable for offloading at sea or using pumping techniques but could be modified or an alternative vessel identified that is of a similar size. It was previously used up until October 2001 after which the mechanical dredging option was employed.



Alternative vessels may have reverse pumps but vessel size, both length and draft, will always be an issue within this dredged area. There are smaller vessels available but they would then face challenges in operating in the exposed channel and bar areas.

4.1.4 Grab Dredger

The MV Mannin is a grab dredger which is owned by the Padstow Harbour Commissioners, that was used for a period when the dredging was urgent. This dredger was able to load/unload using its own grab. It also has a split hopper which could allow sand to be discharged to the seabed.



However, this type of dredger causes holes to be created which fill with seaweed and other materials. This was found to be an issue when re-introducing the cutter suction dredger to the same areas. Dredging rates are similar to the cutter suction dredger.

4.1.5 Plough or Injection Dredger

The plough and injection dredgers rely on pushing the sand out of the way in a similar fashion that the effects of sluicing would have. These dredgers are likely work well in combination with other methods but have not been used at Hayle to date, with further investigations being undertaken by the HHA Harbour Master.

A number of benefits of this type of dredging would include the retention of sediment within the St Ives Bay cell, negation of need for testing, screening, disposal and for any land-based transportation. However this would not provide a cost-effective solution if it was to be solely financed by the harbour users through their harbour dues.

4.2 Transportation of Sand

It is possible to transport sand via road or waterborne transport depending on its final destination. Road transport has historically been used and the sand delivered in-land. Opportunities exist to pump the sand to shore although this is only likely to occur if a capital dredging process was required. Alternatively, sand could be transported by sea to a designated offshore disposal site for beneficial re-use by placing it back within the St Ives Bay sand cell.

As the sand is classified as “controlled waste” by the Environment Agency then the transportation of the sand once it is landed is subject to The Controlled Waste (Registration of Carriers and Seizure of Vehicles) Regulations 1991 (as amended) which requires any person who carries controlled waste for profit to be registered with the Environment Agency. All waste transfer notes are held by HHA in the Harbour Office for viewing at any time.

5 End Use of Dredged Sand and Transportation

5.1 End -Use

The use of the dredged sand has historically been for the farming industry as bedding material and subsequently soil improvement, as it has similar properties to lime.

The monitoring of recent waste tickets and sand sales as revealed that there are other minor uses such as construction, textured paint, arts and crafts, playgrounds, and cat litter. However, all of these uses are of a very small volume and do not constitute viable opportunities.

An experiment was conducted during the adverse winter weather to ascertain if sand could be used in place of salt on the road system but it did not prove to be successful, indicating how quickly the sea salts are washed off of this material.

It was intended that this end-use could be monitored and explored in more detail. However, the predominant sales are for farm bedding and as such, any detailed analysis would be of little consequence.

5.2 Storage & Transport

The relatively small monthly volumes of sand being dredged allows it to be stored on site and consequently removed with limited impact on the surrounding roads. Storage on site was limited within the conditions of the licence in order to reduce the likelihood of objections being raised by local pressure groups who would not wish to see the sand being removed from St Ives Bay. Section 6.2 of the licence required HHA to “ensure that no more than 5,000 tonnes of stockpiled dredged materials shall be permitted on the Harbour quayside for non-replenishment use unless the Council agree otherwise.”

Off-site storage is the responsibility of the owners of the sand once it has left the premises of HHA.

6 Physical Properties and Chemical Status of Dredged Sediment

6.1 Background

Whilst not quite the cradle of the Industrial Revolution, Hayle can claim to have made a major impact upon industrialisation worldwide in the 19th Century. It is this industrial heritage which is crucial, both to the current nature of Hayle and to the dredging proposals. North Quay became the site of a power station, serving most of West Cornwall with electricity and getting its coal from South Wales by sea. This heritage has left Hayle harbour with areas of contamination, which during dredging could be disturbed and pollute surrounding water bodies.

However, the zones for the maintenance dredging are identified to minimise any chance of contamination. Some coal dust was identified at North Quay but otherwise the sand properties have been similar to those identified on the surrounding Hayle beaches. Prior to 2008 there was little information available but since then the sand testing has been undertaken in accordance with the CPA licence conditions. Full detailed analysis is provided in Appendix D.

6.2 Benchmark Analysis

The areas requiring dredging were sampled in 2008 for waste assessment purposes and all samples were classified as non hazardous. Leachability testing of the material was not undertaken as it was considered unnecessary as the sands are only present at the surface at periods of low tide.

The sampling locations for the benchmark analysis were selected to satisfy the following objectives:

- Obtain background metal concentrations for Gwithian Sands Beach;
- Determine metal concentrations within the key areas of the estuary that were identified as requiring dredging;

The depth of the sampling points was originally determined to mirror the depth of the proposed dredging scheme. On site, the depth of the locations was limited by the ability of the sampler to achieve the required depth using conventional hand tools within the tidal limits of the Harbour. Obtaining samples at greater depths could only practically be achieved using coring techniques for which there was insufficient time or reason. Practically the locations were also influenced by the advice of the Harbour Master with respect to Health and Safety of those taking the samples at low water.

The areas tested are as indicated in Figure 3 below.

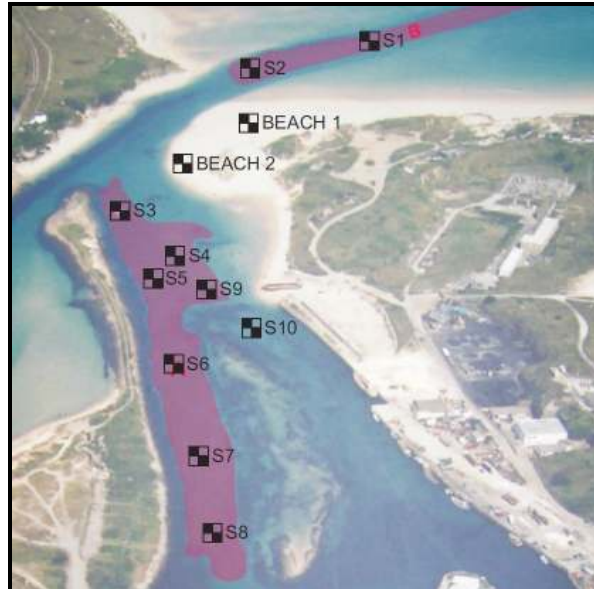


Figure 3 – Benchmark Sample Locations

Excavation into the sand banks in the north of the estuary showed staining by natural organic material, such as seaweed, below approximately 0.6m bgl. This sand is unlikely to be suitable for re-use on the beach because of aesthetic reasons associated with its colour and odour. Samples taken from this strata contained similar concentrations of determinands as samples taken from the overlying sands and sand present in the banks down stream. Sands that have been stained and have an odour should only be used for agriculture and should not be used to replenish the beach above mean high water level.

The colour and odour of the sands vary with depth but the results of the above survey indicate the chemical properties of the sands will remain relatively constant with respect to depth in the harbour area. It has not been considered necessary to undertake further ground investigation to verify this (principally due to the practical and cost implications). Dredging is being undertaken to a depth of 1.5m below ground level where samples have been taken.

Dredged materials will be stockpiled on the quay and tested at an approved laboratory to determine its acceptability for re-use on agricultural land or for beach replenishment. The total amount of sand requiring testing is unlikely to exceed 1400 tonnes (approximately 2,800 m³) in any month. The dredger is only capable of providing 200t loads and each load is stored separately to enable quality/use controls to be put in place.

6.3 Verification Sampling and Testing

The verification sampling is undertaken by an independent company. It was decided that the Cornwall Council Laboratory would provide the most economic service and a contract between them and the Harbour Company was subsequently agreed.

The sand is stockpiled on harbour land in piles that represent the areas from which they were taken, where necessary. Each stockpile is then sampled and tested by the laboratory. Experience has shown that there is little chance of any poor test results being identified and the contractors responsible for the dredging remove the sand off site before the tests are returned. However, HHA must ensure the sand is not sold until tests are confirmed and that the relevant sand stockpiles, on or off-site, can be identified should there be found to be a problem.

An area of dark staining of sand was found to be caused by coal dust and this material was deposited on the dune replenishment area prior to testing. Whilst the test results identified this as a potential contamination problem, the levels of contamination were not harmful and the material allowed to be left in place. However, this highlighted the need to stockpile carefully in order to be able to identify future contamination issues prior to re-use or sale of the sand.

7 Monitoring Requirements

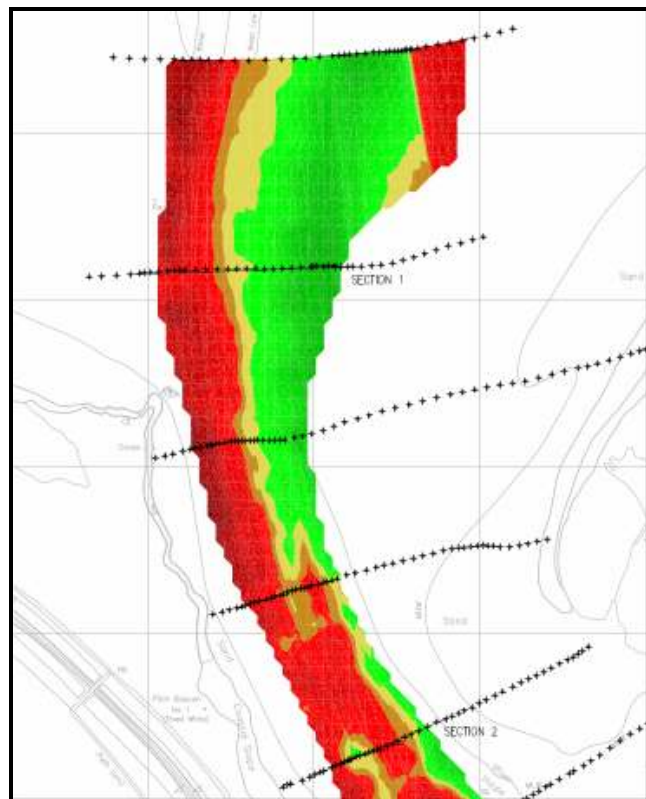
7.1 Monitoring Requirements

The following monitoring has been considered appropriate during the recent maintenance dredging that has been undertaken since 2008.

- Monthly records of sand removed
- Monthly records of the properties of the sand removed
- Monthly records of sand sales/destination
- Annual bathymetric surveys

These records have been made and distributed at quarterly meetings of the dredging group put together by the Council in response to the requirements for obtaining CPA Consent.

Using some historical levels it was possible to consider general areas of the dredging improvements in the first year of maintenance dredging.



This simply confirmed what could be seen on site with the channel moving back to the west (red) and the beach levels recovering where the channel had previously meandered across to the east (green).

7.2 Comparison of Bathymetric Surveys

It is intended that the results of Bathymetric Surveys can be compared in order to assess the impacts of the dredging on the harbour and estuary. For example, the two recent Bathymetric Surveys that have been undertaken within the harbour which were undertaken on 16th July 2009 and 26th April 2010 shows that there has been a net total volumetric increase of 24,820 tonnes (14,600m³ x 1700kg/m³) between the two bathymetric surveys, shared evenly between the inner and outer channel zones. This is despite a total of 25,000 tonnes being dredged in the same period, as indicated in section 10.3. More bathymetric survey information is provided in Appendix F.

7.3 Associated Monitoring

In addition to the above, various studies and surveys have been undertaken that can be used to monitor the maintenance dredging impacts. These studies and surveys have been undertaken as part of the maintenance of the SSSI, St Ives Bay or as part of the investigations into the redevelopment opportunities for Hayle Harbour. The details of these studies are covered elsewhere in this document.

7.4 Future Monitoring

It is not intended that any additional monitoring will be undertaken by the harbour company other than the requirement of the licence as currently provided. The monitoring requirements in 7.1 will therefore be continued for all maintenance dredging activities with additional studies provided to meet consent requirements for capital dredging projects or disposal activities.

Additional monitoring of coastal processes is being undertaken by other responsible organisations, see 10.3 below, and this data is available to the harbour company when required.

7.5 Monitoring of Replenishment Zones

As part of any replenishment work, there will be monitoring requirements. For the recent Penwith dredging licence the monitoring was on a visual basis. However, a more informed method of monitoring could be considered in line with the recommendations made for dune management within the Shoreline Management Plan (See Appendix E).

8 Environmental Impacts

Consultation with Natural England under either section 28H of the Wildlife and Countryside Act 1981 (as amended)(WCA) by HHA or under section 28I WCA by Cornwall Council through the CPA licensing process is needed for any maintenance dredging operation. The dredging protocol will form part of any consultation for future maintenance dredging activities.

The harbour is within the Hayle Estuary and Carrack Gladden SSSI as shown in Figure 4 below.



Figure 4 – SSSI Boundaries as Defined on the Natural England Website

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Natural England has provided the Conservation Objectives for the Hayle Estuary in order to assist in the evaluation of the impacts of the maintenance dredging on European Sites within and adjacent to the Harbour. This is provided in Appendix B.

Within Appendix E is the extract from the Shoreline Management Plan, where the Hayle Estuary is within Management Area reference MA27 and this itself is within the St Ives Bay Policy development Zone PDZ10. The only reference within this document to dredging is in consideration of the loss of dune frontage expected along Harvey's Towans. In the extract (draft) it states that "...foreshore levels may raise themselves in response to sea levels. The future response may partly depend on future dredging strategies and how much sediment is removed from the estuary system."

Other works have been undertaken, particularly as part of the Harbour Development project that will help to support the protection of the harbour environment.

8.1 Direct Environmental Impacts of Dredging

Within the Detailed Planning Application EIA for North Quay, as submitted in 2008, the following biotypes were expected to be impacted upon during maintenance dredging.

SS.SSA.IFiSa.IMoSa	Infralittoral mobile clean sand with sparse fauna
LS.LSa.MoSa.BarSa	Barren littoral coarse sand
LS.LSa.MoSa	Barren or amphipod dominated mobile sand shores
LR.LLR.F.Fves.X	<i>Fucus vesiculosus</i> on mid eulittoral mixed substrata.

The EIA continues. "There is little agreement about the period over which aquatic flora/fauna show recovery from maintenance dredging, with estimates ranging from as little as 28 days (McCauley et al, 1977) to impacts at sites 500m from the dredging and no significant signs of recovery of the dredged area after 100 days (Quigley and Hall, 1999). From knowledge of the invertebrate and fish fauna of the harbour, it is expected that the number of species present would recover within 2-3 years, but biomass recovery is expected to take longer, perhaps up to 5-6 years from cessation of dredging.

The biomass supported by subtidal sediments in the dredged area would fluctuate with the dredging regime. Biomass in the dredged area would tend to be at a minimum immediately after dredging and at a maximum immediately prior to the next dredging event. This fluctuation in biomass would have some impacts on the biomass of fish that can be supported in the dredged area. A minor adverse impact is expected."

8.2 Environmental Impacts of Dredging

There are currently no known indirect impacts of the dredging except for the potential for beneficial impacts of water levels being lowered at low tide and hence more inter-tidal area being created for wading birds and other species that require inter-tidal habitat. Observations of low water levels in the harbour since dredging recommenced in 2009 indicate a lowering of water level from between 0.5 – 1.0m. This is reported by harbour users as low water levels as previously seen when sluicing was undertaken. A consequence of this is also the loss of sub-tidal habitat which could be considered an adverse impact although further surveys would be needed to confirm whether there are any impacts at all.

There are no known environmental impacts on St Ives Bay. However, the currently available evidence indicates that the St Ives Bay sediment cell functions as a 'closed' cell where there are sediment movements within the cell but not in or out of the cell. The work undertaken for wave hub considers St Ives Bay to be a full sand cell and hence no passing sediments can enter it. There remains significant differences in professional opinion on this issue of a 'closed' sand cell.

While dredging at Hayle may not, in itself, affect the cell, the subsequent removal of sand over a period of time (i.e. the cumulative effects) may eventually result in drawdown of sediment from beaches and adjacent sand dunes as the cell adjusts through the natural processes operating within it to maintain equilibrium, particularly under conditions of sea level rise. This indirect impact of ongoing removal of sand and the measures needed to prevent or mitigate adverse effects need further consideration. Should replenishment of dredged sand in the bay occur, as noted in 9.4 below, then the cell is less likely to be impacted upon but any direct impacts of the deposition of sand on the sea bed would also need to be considered in more detail.

9 Replenishment Options

9.1 General

It is widely recognised that the ideal option for any dredging of sand would be to replace it within St Ives Bay and not to remove it permanently. This is because the sand cell is considered by some as being “closed” although in reference to the 2009 Wave Hub Sea Bed cable Study it is believed to be “full” and hence not able to receive any further sediment.

HHA has therefore undertaken a slow process of sand removal from the sand cell that enables a better understanding of impacts upon the environment through survey and monitoring.

Any replenishment of sand directly back into the St Ives Bay will have financial impacts upon the users of the harbour. Such socio-economic issues should not be under-estimated as the funding of dredging using harbour dues would make the harbour unaffordable for all users. The cost impacts of this are considered in more detail in 9.4 below.

9.2 Dune Replenishment

The harbour company has used the 20% replenishment sand for dune replenishment over the past two years. This 20% was arrived at through negotiation with Penwith District Council and the consultees to arrive at a figure that could be justified and accommodated by the proposed dredging contractor. The removal of sand would effectively pay for the dredging operation and hence a minimum volume of sand was required to be removed to make the operation commercially viable. This agreement relied on the information provided by the dredging contractor and the limited knowledge of the commercial value of the sand.

One area has been completed and this is to be completed under the expired Penwith licence. The areas were chosen because of their low lying nature, being protected by adjacent dunes, being old chalet spaces that have since been removed and areas that need Sea Buckthorn management. This meant that several other environmental actions were being undertaken by the harbour company whilst meeting the replenishment requirements.

The original dune replenishment used un-screened sand resulting in unwanted materials within the sand dune. Future dune replenishment will use screened sand. Planting of the dune was not intended and some natural grassing has occurred. It is evident that a more formal method of promoting grass growth is needed and this may be in the form of small wind breaks to collect wind blown sand and seeds.

The dune replenishment works have also assisted in better defining the walking routes through the dune system and thereby protecting it from disturbance. Further consideration of low level fencing and walk-boards is needed to allow dune grasses to develop.

Using the guidance from the Shoreline Management Plan (Appendix E) it would be appropriate to put into place a formal detailed management plan for the dune replenishment works.



9.3 Beach Replenishment

The beach replenishment option is restricted by the available land in the harbour company's ownership that is above the MHWL, to avoid additional consents issues. A small area of beach was replenished within the harbour area to meet the desires of the local town mayor. However, no formal areas have been identified for this purpose.

It may be possible, subject to finances, to consider the option of lifting sand from the channel and placing directly on the exposed beach. This will use the mechanical digger dredging method and would be subject to other consents and additional harbour dues from the harbour users. Any future beach replenishment works will require the agreement of the dredging consultees through the CPA / MMO processes discussed in Section 3.

9.4 St Ives Bay Replenishment

On 6th August 2008, Buro Happold requested a scoping opinion from the Marine Consents Unit for a "Sand Replenishment Zone" to be established in St Ives Bay – see Appendix C. The MCU advised verbally that this would require an application using Form MCU3 and would be a straightforward process as the work was for "Beneficial Use".

However, the cost of undertaking dredging without being able to fund it using sand sales will be restrictive. Indicative costs can be based on an average cost of £5/tonne. Hence for a 40,000t maintenance dredge, the cost would be £200,000 per year. However, this is likely to be the "local" rate and would need to be uplifted if the work was undertaken by a national contractor who would wish to undertake the work in a single visit.

An alternative measurement, given the congested area of the harbour would be to consider the output of the MV Mannin when it was used in 2008. The vessel cost £51,750 and is recorded to have removed 15,785t from the harbour to the quayside. If the same vessel was to remove the 40,000t and dispose in the bay then (providing an uplift of 25% for bay disposal/weather delays) the cost would be in the order of £164,000. In January 2009, the MV Mannin removed 4,800t in the month and hence the overall time required to remove

40,000t would be of the order of 9 months which may not be possible given the wave conditions during the winter period, when fishing vessels can not operate from Hayle.

Such capital costs of dredging exclude the licence application, disposal site surveys, monitoring and other associated costs. Simply put, the cost of this work could not be added to the harbour users dues as it would increase these by some £1,000 which would be unacceptable. The socio-economics of increasing harbour dues above inflation would be harmful to Hayle Harbour and to the town as a whole.

9.5 Plough or Injection Dredging

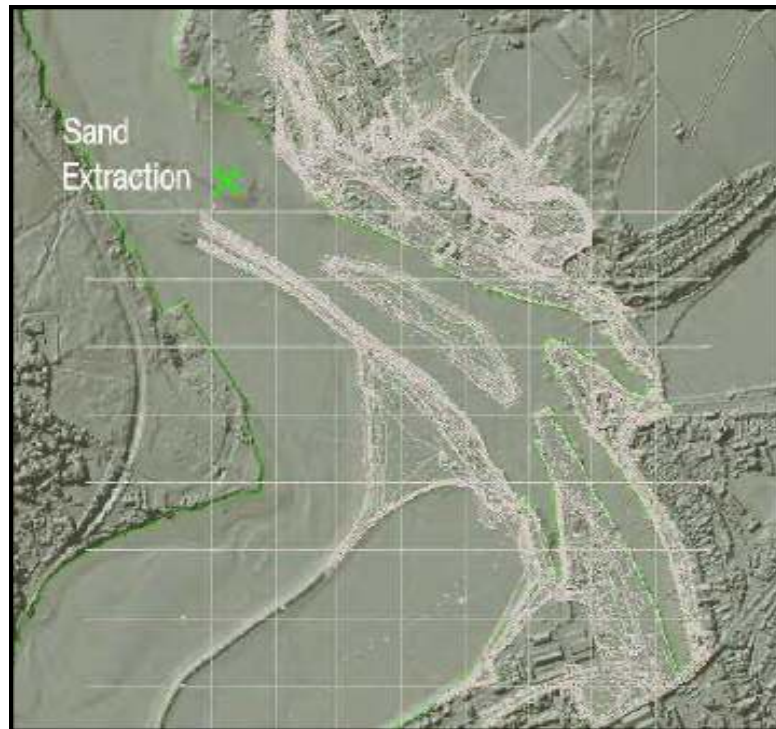
The plough and injection dredgers would provide a direct replenishment of St Ives Bay. Similar socio-economic issues as identified in 9.4 above would prevail although the environmental benefits may be greater as the sand is not lifted and transported from area to area. It is possible that because the sand is only moved locally to the channel then it can be quickly deposited back into the channel as a consequence of tide, wave and wind effects. However, this requires further investigation.

10 Previous Dredging History

10.1 Sediment Management in Hayle.

Mechanical dredging is known to have been undertaken at Hayle Harbour from a location to the North West of the North Quay since March 1999, shown in the map below. During 2003 and 2004 an average of 1,800 tonnes of sand per month were being extracted and this is detailed in 10.2 below. Based on an approximate density of 1.8 tonnes per cubic metre, this equates to an approximate extraction rate of 1000m³ per month.

Dredging was stopped at the end of August 2004 by the owner ING Real Estate (UK) Ltd in the view of concerns from conservationists that it was damaging the environment and causing premature coastal erosion to the beach and surrounding bay.



LIDAR Map Location of Past Dredging

Previously, dredging of the estuary was undertaken without the need for a waste management licence or exemption and the material was sold as aggregate or for land treatment. The potential uses of the dredged material are related to whether the material would be regarded as 'waste' by the Environment Agency and therefore whether a waste management licence or exemption would be required.

There is a significant number of local residents with the memory and knowledge of sluicing within Hayle Harbour. This body of local opinion supports the findings of the hydrodynamic modelling, and reports significant evidence that, over time, sluicing was effective in keeping the navigation channel clear, and had some effect on managing the bar at the harbour entrance. Such an effect would help reduce the navigation risks between the harbour and St Ives Bay.

Historically, sluicing was carried out to sweep the harbour clear of sand. Since sluicing halted the harbour has accreted, suggesting net import of sand. Historical evidence indicates that Copperhouse Pool has accreted substantially over the past decades. The northern end of Carnsew, a deepened area was dredged to create a cooling water pool for the power station which ceased operation years previously.

10.2 Previous Dredging Records

There is limited information available on the amount of dredging undertaken at Hayle. However, through the planning process for the OPA, as contained in the document “EIA – Annex 13b Sediment Exchange Monitoring” it has been possible to identify the following known quantities of sand taken from the harbour from 1999 to 2004.

1999	Tonnes		2000	Tonnes		2001	Tonnes
Jan			Jan	463		Jan	754
Feb			Feb	491		Feb	411
Mar	416		Mar	1565		Mar	646
Apr	342		Apr	718		Apr	1047
May	793		May	792		May	1329
Jun	436		Jun	1335		Jun	2180
Jul	876		Jul	1168		Jul	1281
Aug	497		Aug	953		Aug	1148
Sep	1330		Sep	2748		Sep	2670
Oct	2414		Oct	2213		Oct	3455
Nov	327		Nov	759		Nov	2601
Dec	355		Dec	373		Dec	1796

2002	Tonnes		2003	Tonnes		2004	Tonnes
Jan	2173		Jan	*		Jan	1277
Feb	1252		Feb	*		Feb	1976
Mar	*		Mar	*		Mar	3392
Apr	*		Apr	*		Apr	3216
May	*		May	*		May	1944
Jun	*		Jun	*		Jun	1597
Jul	*		Jul	*		Jul	1890
Aug	*		Aug	*		Aug	1738
Sep	*		Sep	122		Sep	
Oct	*		Oct	1016		Oct	
Nov	*		Nov	927		Nov	
Dec	*		Dec	1789		Dec	

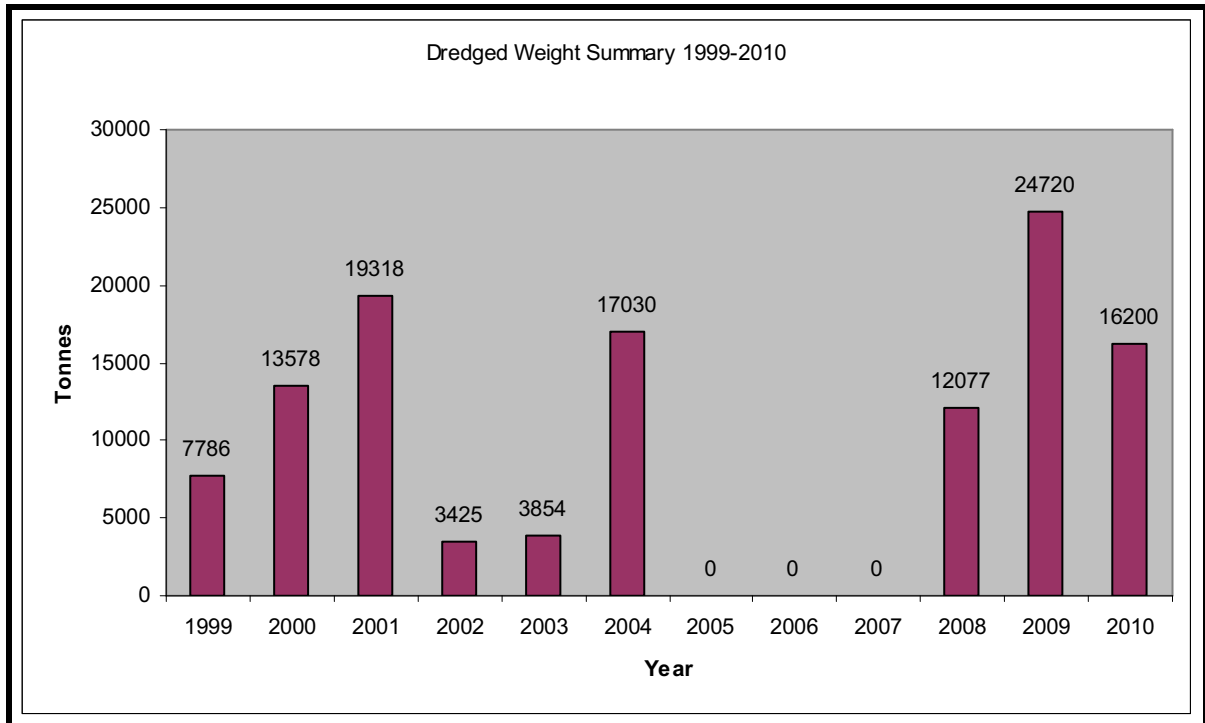
It is unlikely that any other records for this dredging activity still exist.

10.3 Recent Dredging Records

The records for the dredging undertaken under the CPA licence between 2008 and 2010 are as follows:-

Month	2008 Tonnes	2009 Tonnes	2010 Tonnes
January	n/a	5100	4000
February	n/a	1580	4050
March	n/a	3460	5550
April	n/a	3000	2600
May	6	1400	-
June	0	1400	-
July	200	2000	-
August	3009	1400	-
September	4097	0	-
October	1805	3200	-
November	0	1200	-
December	3180	1000	-

Hence, using historical and recent dredging records, the following bar chart shows the weight of sand removed from Hayle Harbour since 1999, based upon available records.



10.4 Beach Levels

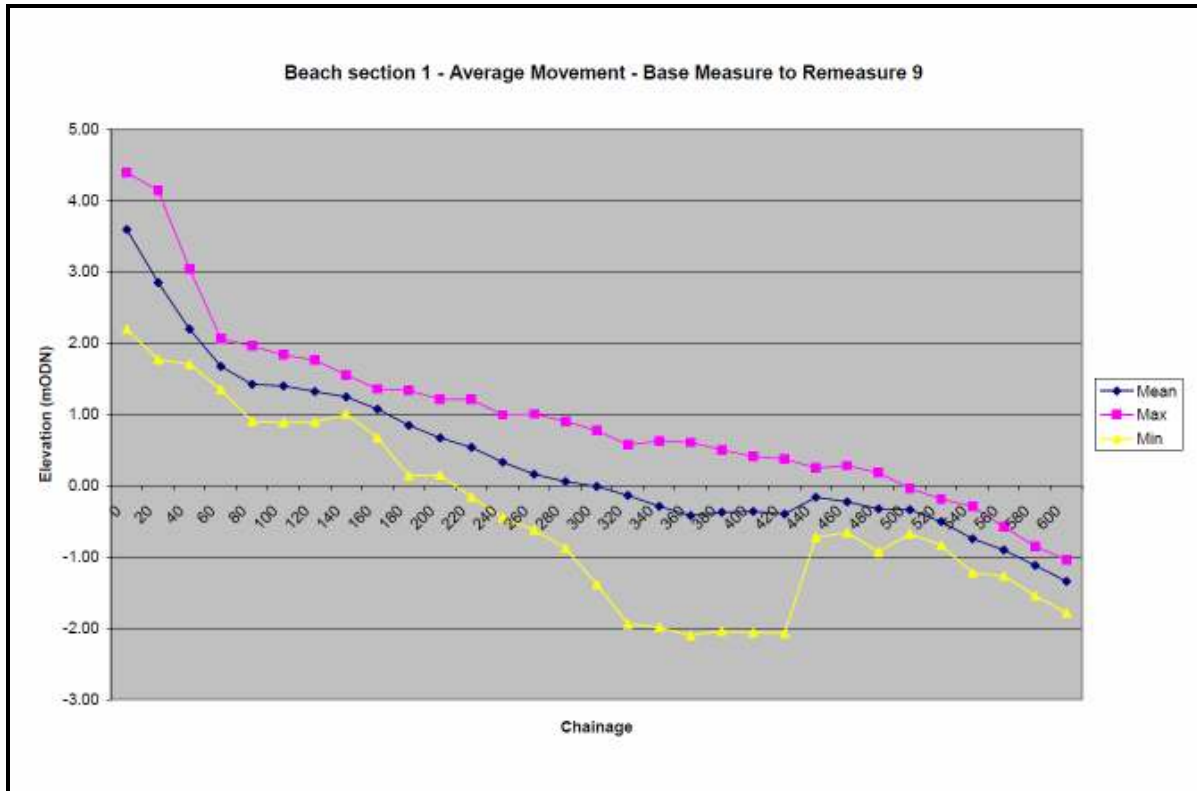
The beach levels continue to vary and there are numerous information sources that indicate reductions and increases in beach levels. The HR Wallingford study "Hydraulic Studies Phase 2 – August 2007" which was undertaken to look in detail at the hydrodynamics within Hayle Harbour identified that the majority of beach movement is caused by wave action within the bay.

Coastal monitoring that was started in 2007 by the Plymouth Coastal Observatory has shown some accretion and erosion of beach levels over a two year period, as indicated in the following extract.



This shows accretion in the harbour channel and doesn't extend as far as Lelant where RSPB records suggest further accretion has occurred. As this survey information is added to then a more full understanding of the changes in beach levels will be possible as the above is a snap shot in time of a very dynamic beach. The impact of the maintenance dredging is considered to be minimal given that historically the sand was dredged and a much deeper channel was maintained with no known impact on the beach levels.

The work for "Wave Hub" also had beach level monitoring undertaken and this showed a fluctuation in level over a similar period as the current coastal modelling. The figure below shows the impact of the channel moving in an eastwards direction following the ending of the dredging and the channel moving along the beach, as indicated in the aerals in 12.1 of this document.



There is limited information on actual beach levels available to the harbour company from dates significantly prior to the commencement of the coastal monitoring. Other sources of data include reports on the movement of sand in the bay and the impacts of waves and tides on the sediment movement. Other data sources are discussed further in Chapter 12.

11 Other Harbour Works / Options to Reduce Dredging

11.1 General

The marine zone in which Hayle Harbour is situated is extremely dynamic and regularly changing due to weather and tidal patterns. The recent coastal management plan and ongoing survey by the Plymouth Coastal Observatory supports this. As such, these natural effects are often difficult to control and hence any introduction of changes to the physical nature of the site needs to be undertaken carefully.

Opportunities may arise where funding becomes available to consider improvements to be made to existing harbour infrastructure that may reduce the amount of maintenance dredging required. These are described in more detail in the following sections and indicative costs are provided, although more detailed work would be needed to ensure that these prices are accurate.

11.2 Middle Weir

The middle weir separates the harbour from Lelant and channels any flow from the Copperhouse and Carnsew Pools out through the channel. Similarly it directs flows out from Lelant in a direction that helps to keep the harbour entrance channel clear.



The Middle Weir also provides protection to Lelant from incoming waves during severe NW storms. During these storms significant amounts of sand are known to be moved and this can be readily observed within the Lelant SSSI where sand has built up.

Raising of the Middle Weir could assist in reducing the amount of sand taken into Lelant during severe storms by preventing so many waves, that carry the sand, from overtopping middle weir and entering this part of the harbour. Instead the sand would be deposited in the harbour channel where water flow would remove it. This would need to be undertaken using rock obtained locally and to raise the area by approximately 1m would be expected to cost in the region of £40k subject to access constraints.

11.3 Harveys Towan

It is understood that Harveys Towan was reinforced on the sea facing edge with rock and other materials excavated for the construction of the original power station. The sea facing edge continues to erode and various materials can be seen within the towan build up.

A physical barrier/protection could be provided but this would need to be in a form that is not natural and this has been resisted by environmental consultees as the view was that it should continue to be a sand dune. The Shoreline Management Plan (SMP2) provides advice for the management of Harveys Towan. The cost of this work is not known as more work is required to identify the exact nature of the works required.

11.4 Sluice Structures

The harbour was historically sluiced from Copperhouse Pool and Carnsew Pool. Neither sluice continues to operate with Copperhouse Pool now incorporating a flood gate which is under the control of the Environment Agency.

Hydraulic modelling of the impact of sluicing for the Hayle Harbour Outline Planning Application (OPA) has shown that it would reduce the need for maintenance dredging but not eliminate it. This modelling was based upon the ability to undertake regular sluicing of the harbour all year round.

However, the OPA consultation process identified that sluicing could not be undertaken on a regular basis and that the SSSI needed protecting. This has resulted in a summer only sluicing opportunity for spring tides only which will ultimately reduce the effectiveness of sluicing compared to a more regular process.

Should finance for works become available then the following work could be undertaken to re-introduce limited sluicing, as already identified within the Detailed Planning Application (DPA) submitted for the North Quay Infrastructure Works:-

Clearance of Carnsew Sluice

The clearance of mussel growth from the existing tunnels is known to improve flow into and out of the Carnsew Pool. However, this work has to be frequently undertaken as the mussel growth is significant. The

condition of the listed structure is such that it can not be entered into without repairs being undertaken. The environmental consultees also require the pool to continue to be flushed by the tide during any works. Hence costs of clearance are significant and works only costs are of the order of £70k.

As part of the works it would be proposed that the old concrete slabs on top of the masonry structure, at quay level, are removed to allow improved access to the tunnels for future clearance. This would add some £30k to the budget but should reduce future maintenance costs.

New Sluice Gates for Carnsew Sluice

As part of the OPA, it is intended that new sluice gates are fitted to the Carnsew Sluice. These would be in accordance with Environment Agency requirements in order to ensure all health and safety issues are appropriately addressed. This is a significant cost item and works were recently budgeted within the Hayle Harbour DPA at a cost of £281k. This includes some £50k of works to access the sluice due to its poor condition.

New Second Gate for Carnsew Pool

The new second gate for Carnsew Pool would allow more water to enter the pool prior to sluicing. It is located at the old mitre gates and would replace the existing timber mitre gates with a new structure and mechanical and electrical equipment. This is a significant cost item and works were recently budgeted within the Hayle Harbour DPA at a cost of £326k. This includes the works required to excavate the channel and repair the old harbour walls which are assumed to still exist below the areas of fill within Carnsew Pool itself.

Replacement Gate for Copperhouse Pool

The OPA also identified the opportunity to replace the flood gate with a sluice gate at Copperhouse Pool. The works would depend on an agreement being made between the harbour owner and the Environment Agency in regards to flood risk and associated liabilities. This is a significant cost item and works were recently budgeted within the Hayle Harbour DPA at a cost of £160k. This excludes the works required to the downstream walls that have collapsed on East Quay.

11.5 Entrance Channel

The western edge of the channel has a rock lined edge and this has been maintained over centuries without any need to make improvements to it. The eastern channel edge has historically not needed any protection. Where it has been provided, it has rapidly been lost to the sea because of the wave conditions that are encountered. The channel alignment has always veered towards the east, depending on the weather and tide patterns seen in the particular year. See historical aerials in 12.1 below. Hence further work on reinforcing the edges of the entrance channel is not considered viable for the type of vessels using the harbour now and in the future.

12 Other Relevant Information

12.1 Aerial Photography

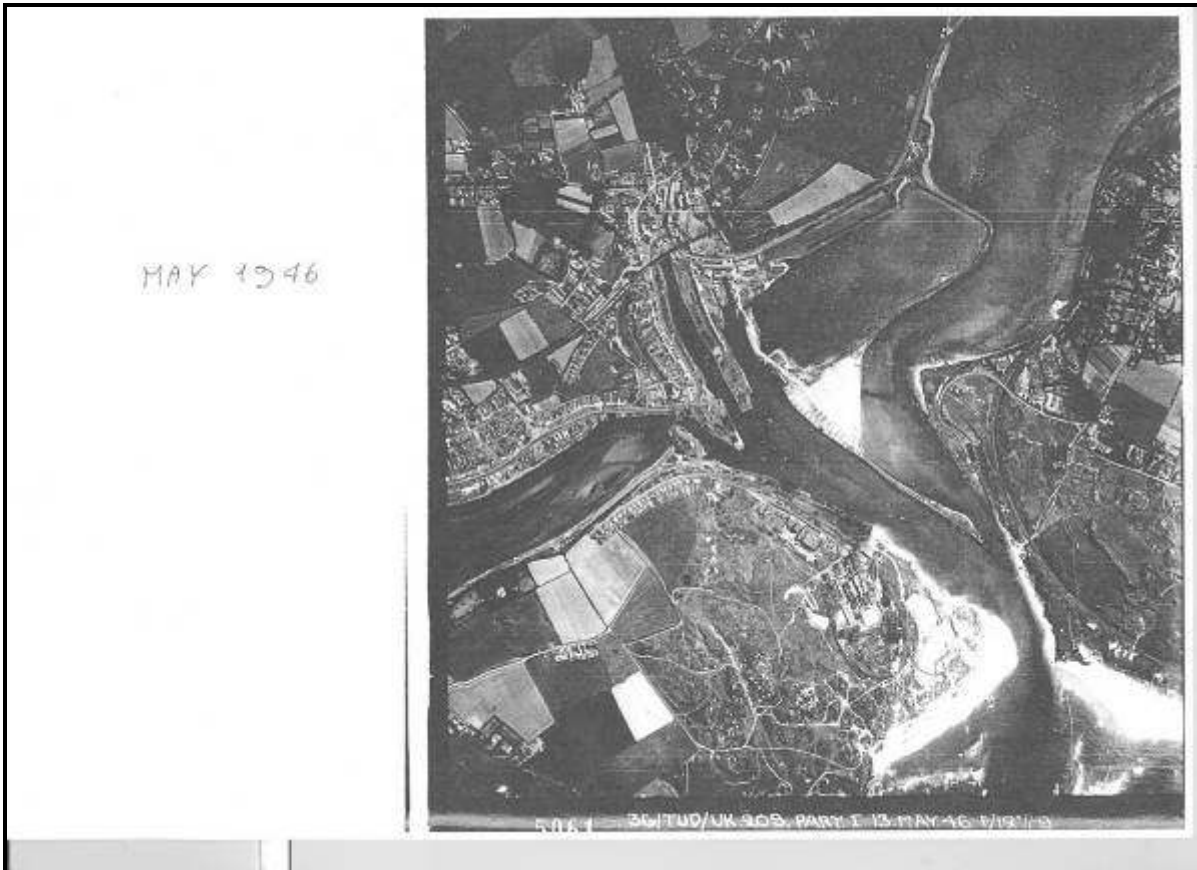
There is a variety of aerial photography available. This shows the channel dispersing towards the east once it has emerged from the harbour entrance. This is consistent with reports made about the channel movement although the extent of dispersion can not be clearly attributed to any dredging work, sluicing etc. as there are no channel depths to correspond with the photography. Similarly, the impact on beach levels can not be clearly defined. There is a deep water channel and it would appear to have no impact on surrounding beach levels.

However, the impact of no dredging is very clear as indicated in the 2009 aerial image, which followed a period of approximately five years without dredging.

1942



1946



1968



JUNE 2008 (Below)



FEBRUARY 2009 (Below)



APRIL 2009 (Below)



MAY 2010 (Below)

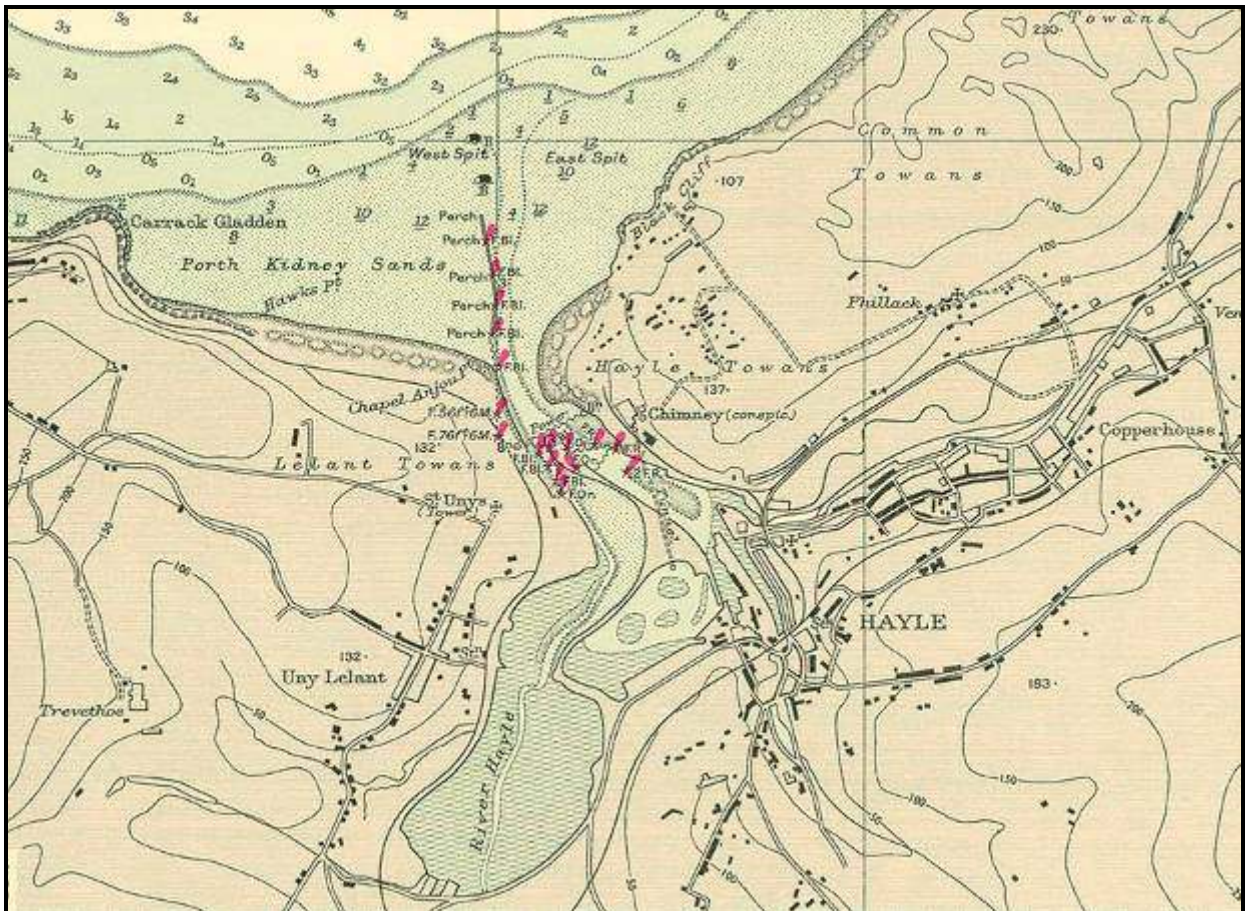


12.2 Historical Charts

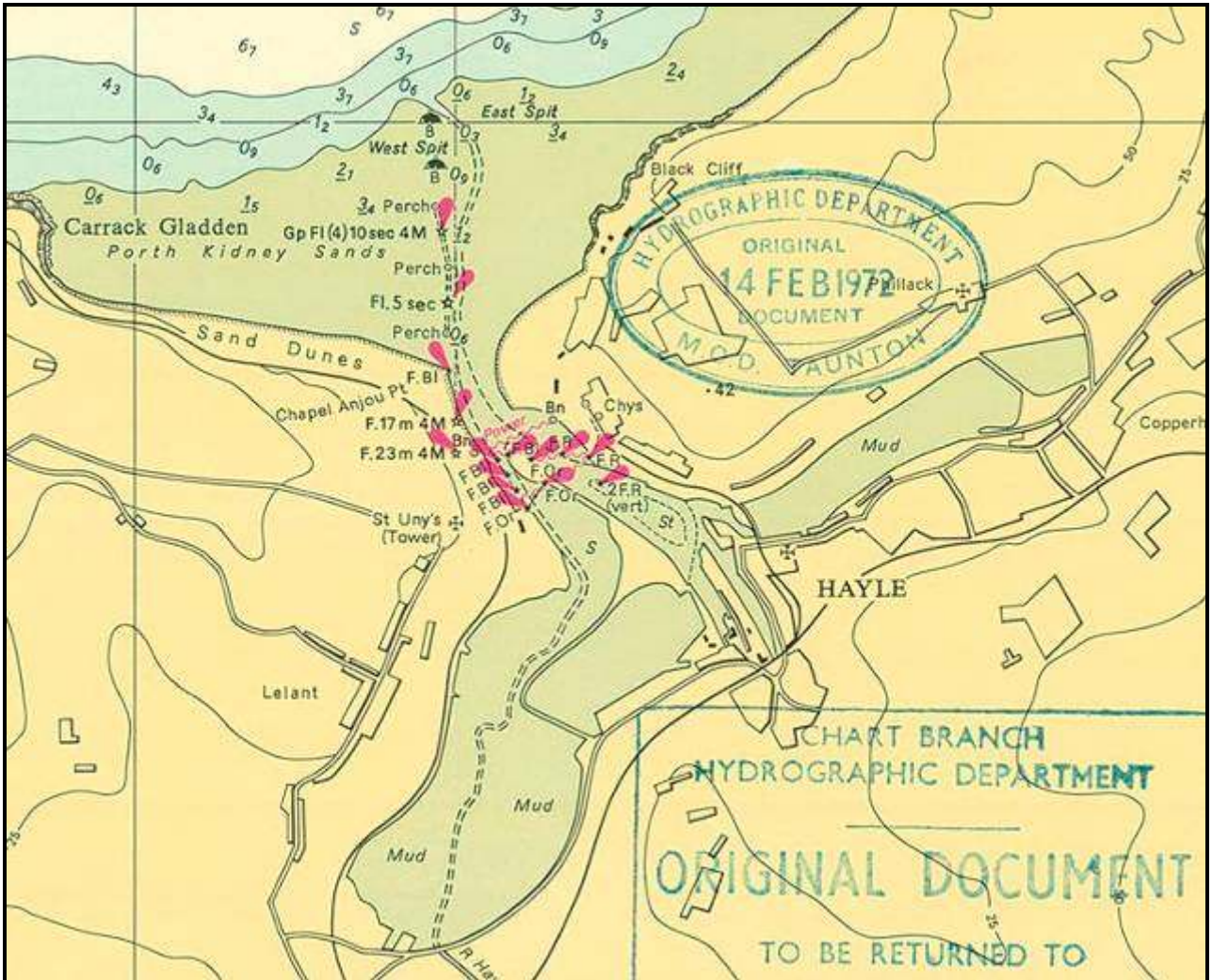
The historical navigation chart revisions for Chart No. 1168 have been purchased from the UK Hydrographic Office and are Copyright protected. For the purpose of this Protocol, extracts from the charts for 1954, 1972 and 1986 are provided below.

The 1972 Chart appears to be the most relevant to the target depths being considered for the proposed maintenance dredging and this correlates well with the time that the port was in frequent use and a channel provided for vessels. By 1986 the commercial activity in the harbour had been lost and the site was under various ownerships prior to the Hayle Harbour Harbour Act coming into force.

1954 Chart (Depths in Feet)



1972 Chart (Depths in Metres)



12.3 Photographs

There are known to be photos of beach levels at highs and lows throughout the years with the most emotive periods being the times when beach levels are low.

The photo below is of the Land Rover lost to the sea some 15 years ago, which makes an annual appearance when beach levels drop during the winter and which is then buried again as sand is deposited during the summer. It should be noted however that the position of this vehicle continues to move in a westerly direction, acting as an indicator of longshore drift, and at some point it will fall into the navigation area when the harbour company will have to remove it, despite other organisations not having to.



12.4 Other

Numerous other information sources are available and it is intended that the dredging protocol adds these to the Appendices as and when they become available. The possibility of a PHD in the sedimentary movements in St Ives Bay by a University of Plymouth post-graduate is currently being monitored.

The Appendices already include the Shoreline Management Plan (Draft), Bates Report (Extract), Wave Hub Reports on the beach processes and levels.

(Appendix / Figures / References)

Appendix A – Sand Testing Results

Appendix B – Hayle Estuary Conservation Objectives (Draft)

Appendix C – St Ives Bay Replenishment - Scoping Request

Appendix D – Wave Hub Sediment Study

Appendix E – Shoreline Management Plan (Extract)

Appendix F – Bathymetric Survey Results

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